U S A T H A M A

U.S. Army Toxic and Hazardous Materials Agency

Remedial Action

DECISION DOCUMENT

February, 1988

Frankford Arsenal

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US ARMY
MATERIEL
COMMAND

DECISION DOCUMENT
REMEDIAL ACTION

Site: Frankford Arsenal, Pennsylvania

Documents Reviewed:

- Final Report on Detailed Survey and Alternative Assessment of Frankford Arsenal. Contract No. DRXTH-ES-2A-81305. Battelle, OH. (November 1978).

- Final Report for the Frankford Arsenal Decontamination/Cleanup Program. Rockwell International, Atomics International Division, Energy Systems Group. (January 1981).

Description of Selected Remedy:

The remedial action consisted of the following decontamination operations:

- Radiological decontamination of buildings through off-site removal of radiological waste.
- Flaming of explosive residues on building surfaces and sumps.
- Removal of heavy metal residues from sumps and repainting building surfaces with paint having low lead content.
- Demolition of buildings in the 400 Area after removal of asbestos and explosive residues.
- Removal of cannonballs lodged below the 329 Area Platform.

Declaration:

In 1976, the Army declared the Frankford Arsenal (FFA) excess to its needs. It contracted Battelle Columbus Laboratory to conduct an environmental survey to assess decontamination requirements prior to the release of the property to the General Services Administration (GSA). The survey identified low levels of heavy metal residues, explosives residues and radiological contamination.

Based on the results of an initial and a follow up survey, a three phased cleanup operation was conducted. The methods selected were deemed consistent with the goals of decontaminating the site within a short time frame of 17 months, i.e., by February 1981. All operations were conducted in accordance with Army-approved procedures. Post-cleanup data indicated that the approved cleanness criteria for the contract-identified facilities and contaminants were satisfied.

All lands and buildings/structures confined within Frankford Arsenal, Philadelphia, Pennsylvania, have been given a visual inspection, sampled and analyzed, and have been cleared of all toxic and hazardous materials reasonably possible to detect using present state-of-the-art methodology. This tract of land can be released for unrestricted use.

APPROVED: Harold Mashburn Date: 31 Mar 88

HAROLD MASHBURN
Colonel, CM
Commanding
U.S. Army Toxic and Hazardous Materials Agency

SUMMARY OF REMEDIAL ACTION SELECTION
FRANKFORD ARSENAL

SITE LOCATION AND DESCRIPTION

The Frankford Arsenal (FFA) is located on the Delaware River in the northeastern section of Philadelphia, Pennsylvania. It is sited near the Pennsylvania side of the Tacony-Palmyra Bridge, south of Tacony Street and I-95, and north of the Delaware River (Figure 1). The arsenal facility included approximately 110 acres of prime river frontage and 120 permanent, 56 semi-permanent and 36 temporary buildings. There are 8 miles of intersecting roadways and about the same mileage of subterranean tunnels at FFA. This decision memorandum does not address areas of Fort Dix, New Jersey which were operated by the FFA personnel for additional experimental projects and test firings.

SITE HISTORY

The Frankford Arsenal was established on May 27, 1816 on a tract of land at the corner of what are now Tacony and Bridge Streets. The reasons for selecting the site were: "The superior facility and economy of water carriage, and the arrangement of storehouses, magazines, laboratory and workshops such that in the event of fire or explosion a part only would be damaged or destroyed." During its 161 years of operation, a variety of activities including munitions manufacture, materials research development activites, development of propellant and cartridge actuated devices, and a variety of procurement missions were carried out at the arsenal.

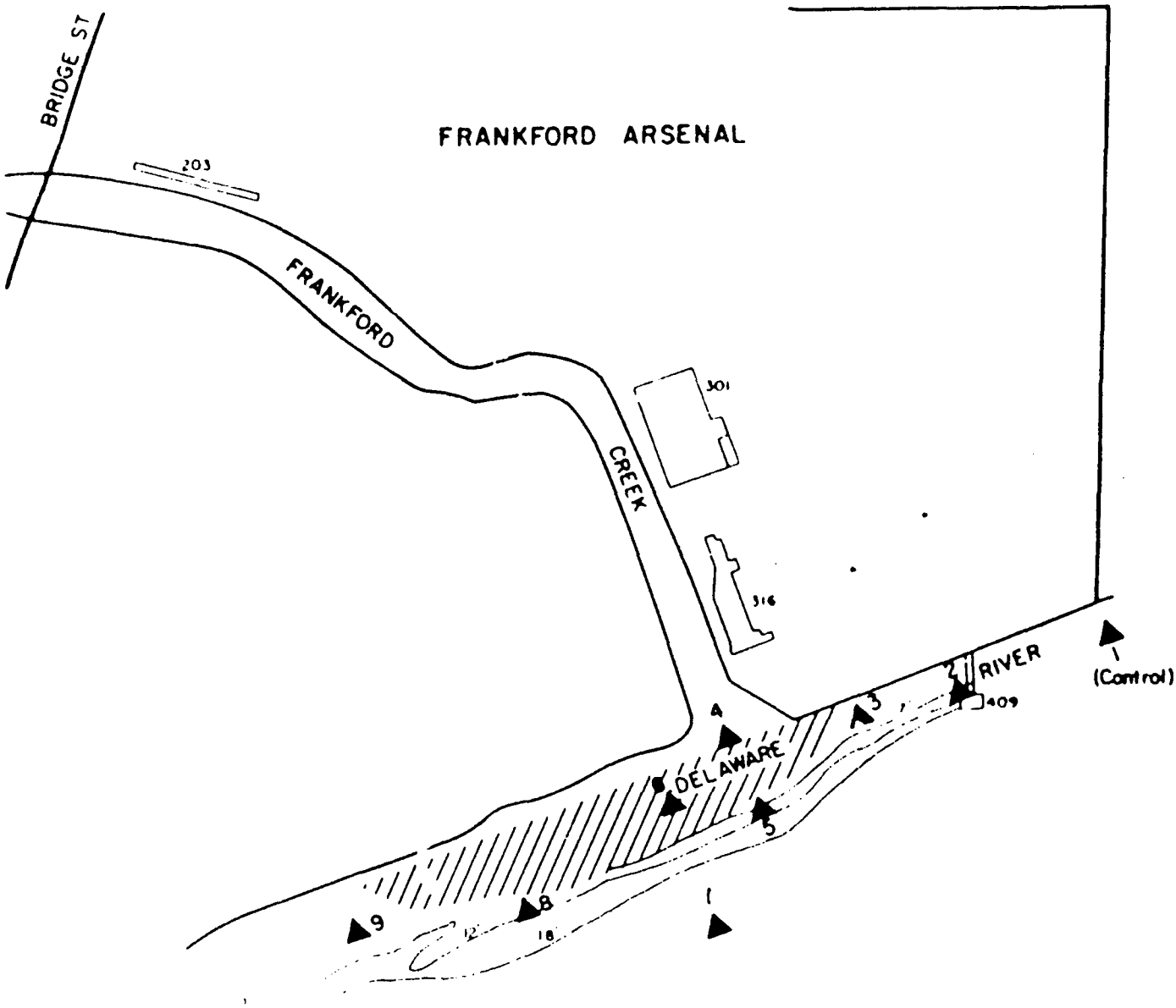

Figure 1. Map of Frankford Arsenal adjacent to Delaware River.
Source: Battelle, 1978.

SITE STATUS

The purpose of the decontamination survey was to establish the level of contamination. A preliminary survey was conducted and followed up with a comprehensive survey.

The preliminary survey did not identify any building whose radiological contamination levels posed a serious threat to occupational workers. A portable gas chromatograph was used to test the buildings for noxious/explosive gases. Those with concentrations above 0.5 ppm were detected in buildings listed in Table 1. This information was relayed to the Arsenal staff so that corrective action could be taken.

After the preliminary survey, a comprehensive survey of building surfaces, vents, surface water, groundwater, sediment, soil surface, sewers and biota was carried out.

BUILDING SURFACES

Building surfaces were sampled using organic swabs, inorganic swipes and indicator sprays in order to determine the level and extent of contamination of building surfaces by explosives, heavy metals and radiation.

Explosives

Organic swabs were used in tests to confirm and quantify, or deny, the existence of explosives contamination.

Heavy Metals

The threshold levels of heavy metals were set at levels presented in Table 2. These levels were based upon the relative toxicities and strictest expected regulations. Building surfaces were designated as contaminated if heavy metal contents of paints exceeded those in Table 2.

TABLE 1
NOXIOUS/EXPLOSIVE GAS REPORT FOR BUILDINGS

Building Number	Sample Number	Concentration (ppm)
45	004	1.000
55	9162	1.000
57	9164	5.000
59	9165	1.000
106	9168	11.000
134	9177	12.000
202	9180	2.000
204	9182	15.000
209	9183	2.000
219	9194	100.000
228	9195	2.000
243	9197	10.000
253	9201	3.000
301	9204	3.000
301A	9205	10.000
302	9206	1.000
303	9207	3.000
307	9209	1.000
316	9211	18.000
320	9125	2.000
320	9125	2.000

Source: Battelle, 1978.

TABLE 2

THRESHOLD LEVELS FOR HEAVY METAL CONTAMINATION
ON BUILDING SURFACES

Metal	Threshold Levels (ug/m^2)
Cadmium	100
Chromium	500
Mercury	20
Lead	500

Several buildings exhibited heavy metal contamination. A detailed list quantifying the heavy metal contamination of buildings is available in the survey report (Battelle, 1981). The heavy metals identified in the survey were lead, chromium, cadmium and mercury.

Radiation

178 samples taken from building surfaces tested positive for alpha and beta radiation. A number of tritium smears were taken at locations where tritium contamination was suspected. Samples were taken off the surface of walls, floors and laboratory hoods. Several buildings exhibited tritium levels above the detection limit of 10.5 pCi/m^2 (Battelle, 1981).

VENTS AND DUCTS

A number of vents and ducts exceeded the threshold levels for heavy metals. Alpha and beta radiation levels in Buiding 316 exceeded the threshold level of 500 ppm/100 cm^2. Except for Buildings 240, 305, 365 and 366, there were no detectable levels of organic compounds or explosives.

SUMPS

A number of sumps showed heavy metal and radiological contamination. Two explosives (nitroglycerine, NG, and Pentaerythritol tetranitrate, PETN) measured at levels above the detectable limits. Test results are presented in Table 3.

SEWER LINES

The primary contaminant of concern in sewer lines was radiological. The sewers of Building 316 exceeded the 1 pCi/ml (pico Curie/ml) level (AEC standard for unrestricted use). The levels were:

Alpha radiation	8 pCi/ml
Beta radiation	22.6 pCi/ml

TABLE 3

LEVELS OF EXPLOSIVES FOUND IN SUMP SAMPLES

Building Number	Sample Number	NG (ug/g)	PETN (ug/g)
58	3736	845	--
58	3738	--	--
58	3740	238	897
68	3783	292	--
68	3784	656	--
122	3143	2040	--
213	3764	804	7879
219	3162	3000	--
244A	3772	2050	--
403	3786	1270	--
415	3726	--	1410
418	3189	--	3000
418	3190	--	3000
419	3192	--	3000
427	3743	--	3000

Source: Battelle, 1978.

The concentrations of metals were well below those of concern. Lead, for example, showed levels of around 0.1 ug/ml in the liquid phase. Solid samples taken from sewer pipes in the 400 Area showed levels of lead in the neighborhood of 100 ppm (ug/g), zirconium up to 2600 ppm, aluminum at 10^5 ppm and alkaline metals at 2000 to 5000 ppm.

AIR

Heavy Metals

The high volume air samples did not show any detectable levels for heavy metals except for lead. The results are presented below.

Building No.	Pb (ug/m^3)
108	216
150	67
312	20
316	108

The allowable level for lead was 200 ug/m^3 (8 hour/day; 5 days/week) or 66.6 ug/m^3 for 24 hours. Buildings 108, 150 and 316 were in violation of the more stringent exposure limit.

Alpha and beta measurements conducted on high volume air samples taken from selected buildings at the Arsenal showed levels of radioactivity not in excess of the suggested criteria.

SOILS

Surface and subsurface soils at various locations on Frankford Arsenal produced evidence of heavy metal contamination. The ranges and average values suggested that the concentrations of heavy metals were above background levels. However, the heavy metal contamination (primarily lead and mercury) of the soils did not present a human health hazard, and cleanup was not required or proposed.

The preliminary survey identified four areas with high background levels of radiation adjacent to buildings 120, 150, 227B and 316. Of these, only the area near Building 227B was not paved. As can be seen from Table 4, several radionuclides appeared in concentrations greater than 1.0 pCi/g in this area. The results of analyses of soil samples for explosives were negative.

GROUNDWATER

The groundwater at Frankford Arsenal is non-potable. Therefore, the drinking water standards did not apply to the site. Sixteen groundwater monitoring wells were sunk to assess the degree of groundwater contamination. The ranges of heavy metal concentrations in the groundwater are listed below. Well No. 13, located in the 400 Area, showed a mercury concentration of 56 mg/L. This was approximately 20 mg/L higher than the concentrations observed in the other 15 walls.

Metals	Range of concentrations (ug/ml)
Pb	0.011 - 1.65
Cd	0.015 - 0.45
Cr	0.0075 - 0.75
Hg	0.00038 - 56.1 mg/L

The ranges of alpha and beta radiation measurements conducted on the groundwater samples is listed below:

	range (pCi/ml)	average (pCi/ml)
alpha	0.001 - 0.225	0.0277
beta	0.001 - 0.07	0.0285

The water quality standard for alpha and beta radiation for the State of Pennsylvania was 0.003 pCi/ml and 1 pCi/ml respectively.

TABLE 4

GAMMA SPECTRAL ANALYSIS OF Building 227B
SOIL SAMPLE

Radionuclide	Activity (pCi/g)
^{40}K	18.2
^{220}Rn	2.47
^{222}Rn	2.21
^{224}Ra	1.43
^{228}Ra	2.34
^{228}Ta	6.88
^{232}Ta	2.34
^{238}U	6.89

SURFACE WATER

The levels of heavy metals upstream and downstream of the Arsenal were statistically indistinguishable, thereby eliminating the Arsenal as a contaminant source (Battelle, 1978). Radiation levels and trace organic species were not present in harmful quantities.

SELECTED REMEDY

Decontamination operations were conducted over a period of 12 months starting in February, 1980.

The applicable Federal, State and local regulations which were considered in specifying the cleanup actions for the site were:

a) for radiological contamination
   1) surface standards for radiological contamination, American National Standards Institute (ANSI)
   2) Army standards (AR-700-64) for radiological contamination
   3) U.S. Nuclear Regulatory Commission regulations
   4) U.S. EPA regulations for radiological decontamination

b) for heavy metals and explosives
   5) 1976 Water Quality Criteria
   6) Fish Aquatic Toxicity
   7) Pennsylvania Water Quality Standards

c) for heavy metals only
   8) OSHA standards for heavy metals in air
   9) National Interim Primary Drinking Water Regulations and Proposed National Secondary Drinking Water Standards.

d) for explosives only
   10) ARRCOM 385-5 - military regulations (Safety, Contamination, Decontamination and Disposal)

The remedial action consisted of a number of decontamination operations for removing various types of contaminants.

Radiological Waste

Radiological decontamination of the buildings was conducted. This involved removal of building surfaces, drains and overhead facilities that were contaminated. The radiological waste was appropriately packaged and shipped for off-site burial to Barnwell, South Carolina. The only exceptions were radium wastes from Building 46 which were sent to Beatty, Nevada.

Decontamination operations for contaminated areas adjacent to buildings (Building Nos. 120, 150, 227B and 316) consisted of removal, packaging and shipment of the radiological material to the burial site at Barnwell, South Carolina. The initial Rockwell survey indicated that the sewers and sumps were free of radiological contamination. The contaminated, concrete encased vents were cleaned by sandblasting. This was preferred because removal of the vents would have required a significant effort. The contaminated sand was shipped as radioactive waste to Barnwell, South Carolina.

Explosive Residues

Exposive residues on building surfaces were destroyed by flaming techniques. Special remote flamers were designed for this purpose. Floor and wall flamers were utilized in larger buildings. Hand and remote flamers were used for smaller and less accessible areas. The sumps were loaded with beds of charcoal soaked with kerosene, aerated and flamed.

Heavy Metal Residues

In order to restrict the bioavailability of lead-based paint after release of the Arsenal for unrestricted use, the buildings were painted with a paint containing no more than 0.06 percent lead. The heavy metal sludges from sumps were disposed of in an approved landfill. The sumps were thoroughly rinsed with high pressure water and sampled in accordance with Army-approved standard operating procedures. The vents did not require decontamination since they satisfied cleanness criteria.

Removal of 329 Platform

In order to remove cannonballs lodged beneath the 329 platform, the platform was removed and the cannonballs excavated under the supervision of a Naval EOD team. The cannonballs were certified by the team as inert. Rubble was placed in the excavation and the area was backfilled to grade.

Demolition of the 400 Area

Because of the low worth and the history of explosives manufacturing in the buildings of the 400 area, it was decided that the area be cleaned of any explosive residues and that the buildings be demolished. The buildings were stripped of friable asbestos and transite ceiling panels which were packaged and disposed of as asbestos waste (Rockwell, 1981), and the wooden walkways were removed. The buildings were burnt using techniques similar to that for the sumps described earlier. The cleanup and demolition plan for the 400 Area followed the flow chart presented in Figure 2.

SCHEDULE OF OPERATIONS

A summary of the schedule for the decontamination and cleanup action is shown in Figure 3. The first part of Phase I was concerned with the verification of methods for cleanup of heavy metal residues and radiological contaminants. The second part addressed the cleanup of explosives residues. Phase II was also divided into two portions. The first part was development of standard operating procedures for cleanup of heavy metals and radiological decontamination. The second portion addressed procedures for cleanup of explosives residues. Phase III, decontamination operations, was commissioned in February, 1980. The decontamination was completed prior to Thanksgiving 1980 and the documentation by mid-January 1981.

The Statement of Clearance for release of property was submitted in second quarter of Fiscal Year 1982. The property has subsequently been sold.

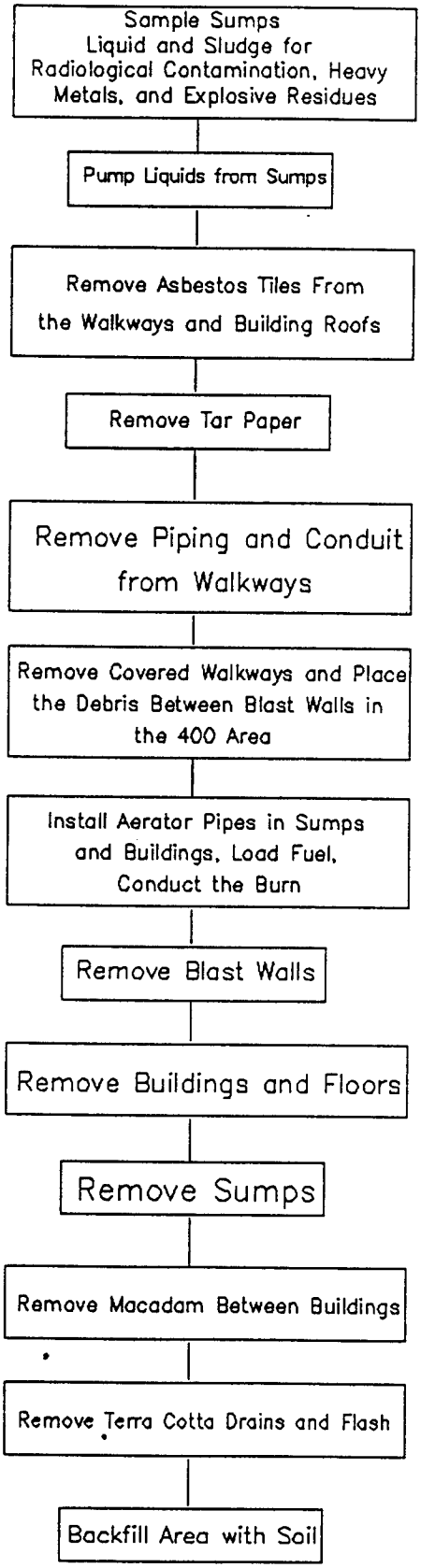

Figure 2. CLEANUP AND DEMOLITION OF 400 AREA

Source: Rockwell, 1981.

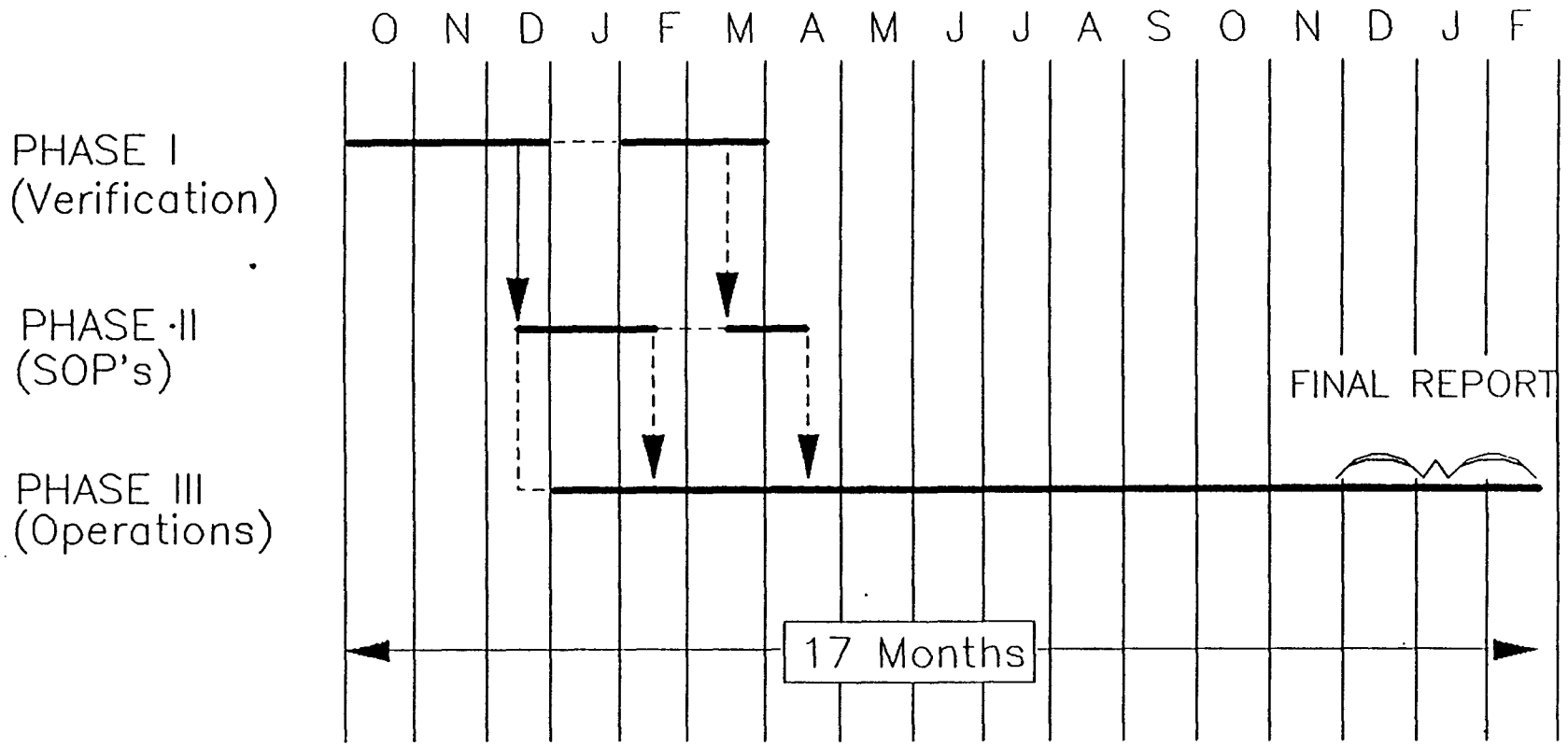

Figure 3. Schedule of Operations.
Source: Rockwell, 1981.

REFERENCES

1. Battelle, 1978. Final Report on Detailed Survey and Alternative Assessment of Frankford Arsenal (Contract No. DAAR11-78-C-0047). Submitted to Chemical Demilitarization and Installation Restoration, MD. Battelle, OH.

2. Rockwell International Atomics International Division, Energy Systems Group, 1981. Final Report for the Frankford Arsenal Decontamination/ Cleanup Program. Rockwell International, CA.

3. USATHAMA, June 30, 1987. Installation Restoration Program, Quarterly Summary.